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A Simulation Platform Design of Humanoid Robot Based on SimMechanics and VRML

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Abstract

Use Virtual Reality Modeling Language (VRML) technology and simulation module in the machine (SimMechanics) in the matlab, design a humanoid robot simulation platform. It enables researchers to carry out their researches on the humanoid robot successfully in the absence of hardware support. Simulation platform designed is simple, easy to operate, can be 3D simulation, the simulation results are more intuitive, can meet the needs of researchers.

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*Keywords:*Virtual Reality; SimMechanics; Humanoid Robot; Simulation Platform;

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1. INTRODUCTION

The development of robot technology is changed quickly. In various forms of robots, humanoid robot is the most integrated, complicated structure and the most similar to a class of human, so it is suitable to work with human in living and working environment. And it can replace humans to work in the environment that is known or unknown, harmful or dangerous, broadening the space of human activities. Therefore, the humanoid robot has great advantages and a wide range of applications.

However, the humanoid robot has the characteristic of high order, coupled, variable structure, variable parameter and nonlinear, making humanoid robot research is very challenging. Due to the high cost of making humanoid robot prototype, it should analysis the humanoid robot through the simulation before making the prototype. And in the basis of successful simulation, the actual prototype can be made. Therefore, design a humanoid robot simulation platform is necessary, which can make the researchers to study the kinematics, dynamics and control method on the simulation platform, and then test at the prototype, to avoid damaging the prototype .

Present, humanoid robot simulation is obtained through ADAMS or robot toolbox. However, the both techniques are not applied universally due to the complex process of making the humanoid robot model. This paper utilizes the Virtual Reality Modeling Language (VRML) technique and the SimMechanics to design a humanoid robot simulation platform. Researchers can compile the algorithms through matlab or Java programming language to simulink on the platform, and to verify the validity of the algorithms.

2. SimMechanics and VRML

2.1. SimMechanics Toolbox

SimMechanics is based on simulink, which is the research and analysis environment of the controller and the object system in a cross-cutting / interdisciplinary. SimMechanics provides intuitive and effective means of modeling and analysis for multi-body dynamic mechanical system and its control system, and all work would be completed in the simulink environment. It provides a large number of the corresponding real system components, such as: bodies, joints, constraints, coordinate systems, actuators and sensors. These modules can be easily utilized to create complex mechanical system model, to analysis a mechanical system separately or to commence a comprehensive simulation between any simulink controller and other dynamic systems.

SimMechanics is a member of the simulink physical modeling, which extends the capability of simulink modeling. The model created by the SimMechanics can be integrated to the traditional model greatly. It provides a set of modules which can be directly utilized under the simulink environment, and to draw the various mechanism modules in the common simulink window, to connect the general simulink module through its own testing and the driver modules, to obtain the simulation results of the whole system. The modules contain the following 7 sub-module, as shown in Fig.1.

Fig.1 SimMechanics modules

2.2. VRML

VRML is the Virtual Reality Modeling Language, was born in the 20th century 90s, is a three-dimensional modeling and rendering graphics and descriptive modeling language utilized to create real-world model. Its object contains three-dimensional aggregates, MIDI data, MPEG image and interaction, etc. These objects are called "node", which contains the basic elements of a "field" and "event". The field is the parameter in the node, event is utilized for the parameter transfer and operation [1]. VRML supports not only data and processes three-dimensional representation, but also provide the node with the sound.

3. Humanoid Robot Simulation Platform Design

3.1. Overall Design Conception

First, compile the matlab program of the algorithm, and then exchange the function date with the simulink. Simulink model is created in the SimMechanics and synchronize SimMechanics data in the Virtual Reality to verify the results consistency. The simulation platform design flow chart is showed in Fig.2.

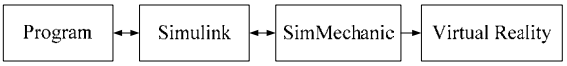

Fig.2 simulation platform design flow chart

3.2. Create Humanoid Robot Model

Humanoid robot model can be created by several techniques; the first technique is to utilize V-Realm Builder in the matlab [2]. Another is to create the whole robot model and then export the model as a VRML file for simulation [3]. Since this technique is to shape the robot as a whole, therefore, any one link parameter (such as link length or shape) changes, other link parameter will change automatically .This lead to modify the link, and the workload is enormous. The last one is to create the each link of the robot respectively and stored as separate .wrl file, then to read these link files to form a complete robot [4] [5].Due to the enormous workload, this paper utilizes the first technique to create the robot model.

In order to achieve the overall humanoid robot model, utilize the following VRML nodes: (1) Transform group node, to achieve the positioning of the coordinate transformation of the model. (2) Viewpoint group node, to set the point of view. (3) Indexed face set node, to create the irregular mechanism. (4) Sensor node, to control the model. The three-dimensional virtual simulation model is shown in Fig.3.

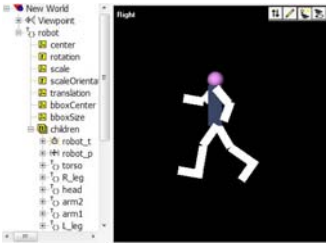

Fig.3 three-dimensional virtual simulation model

3.3. Create Simulink Module

The procedure of create the simulink module is as follows: (1) Select Ground. body and Joint module. (2) Set environmental parameter in the Machine Environment, such as the gravity vector. (3) Set the base coordinates, and consolidates the robot system in the inertial coordinate system. (4) Set the link parameter in the Body module, such as weight, inertia tensor matrix. (5) Connect the link by the Revolute. (6) Connect, select and configure the Actuator and Sensor module. Actuator module is utilized to input the simulink signal to the joint. Sensor module is the measurement module, which will input the angle, speed, acceleration and force of the joint to the simulink.

Package the module controlling the each joint as a subsystem, showed in Fig.4

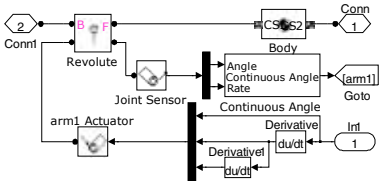

Fig.4 subsystem

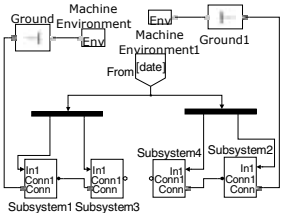

Fig.5 Overall SimMechanics model

Coon1 and Coon2 is connected the links. Continuous module transforms the angle signal by Joint Sensor to continuous signal utilized in the VR sink. Actuator module is responsible for the first and second derivative of the input signal to each joint. The robot joint can be controlled through the simulink. This paper selects four joints to control, which are shoulder and hip joints. Therefore, it needs four subsystems. Connect the subsystems, shown in Fig.5.

3.4. Connect the Robot Model and the Simulink

In order to realize the overall simulation platform of the humanoid robot virtual reality model and the simulink, it need to put the robot model created in the V-Realm Builder into the Virtual Reality Toolbox, then drive the model by simulink. The procedure is:

(1) Set a new simulink file.
(2) Add the VR Sink and VR Signal Expander module to the file. The number of the VR Signal Expander module is similar to the joints to be controlled.
(3) Add the robot model to the VR Sink module.
(4) Select the joints. This paper selects the shoulder and hip joints, which are showed in the Fig.3:arm1, arm2, R_leg, L_leg node.

See the connection between the robot model and the simulink in Fig.6.

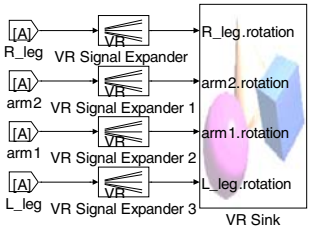

Fig.6 VR Sink connection

3.5. Overall Simulation Platform

According to the design conception, connect the each module, and then achieve the overall virtual reality simulation platform of humanoid robot, shown in Fig.7.

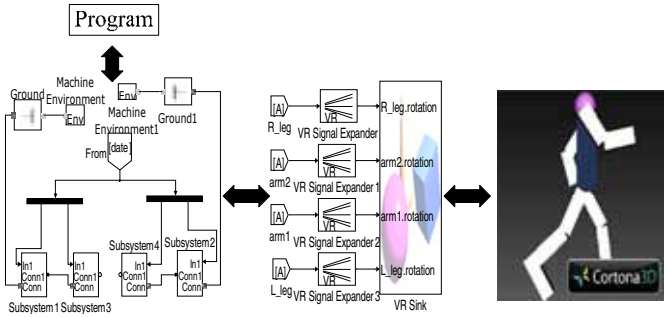

Fig.7 Overall simulation platform

4. Conclusion

In this paper, we present a simple and reliable approach of creating humanoid robot platform based on the SimMechanics and VRML. This approach is low cost, easy to operate. Also, it has a good scalability. Therefore, put the robot platform into the different virtual environment, different studies can be conducted, such as walking control, arms coordinated operation, multi-robot coordination manipulation.

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